Group-2 Consortium reference event collection and validation of models and corrections
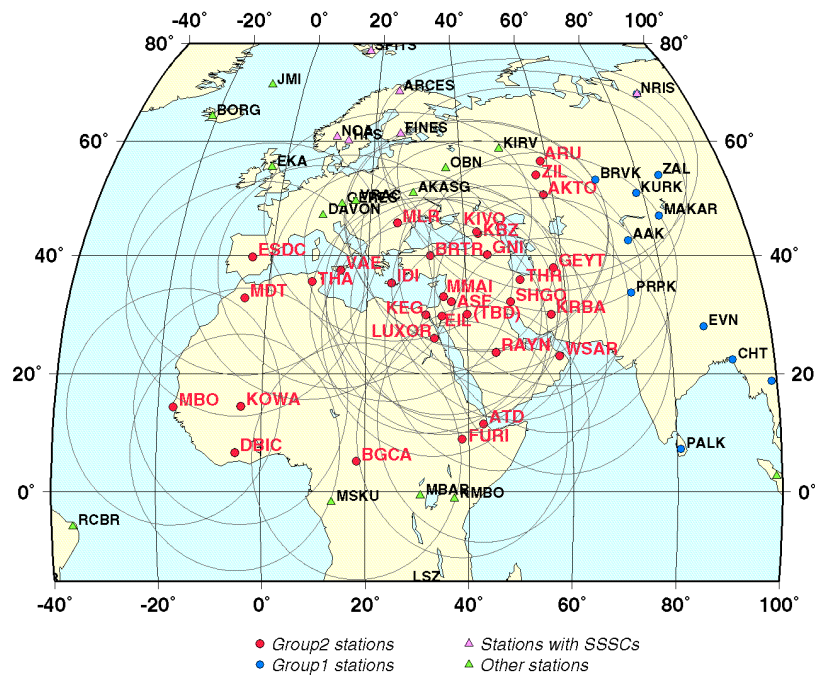
Group-2 Consortium

SAIC, CUB, Harvard, GII, Multimax, UCSD

The Third Location Workshop

Oslo, Norway, April 23-27, 2001

http://g2calibration.cmr.gov/calibration/Presentations/Oslo/Oslo_refval_2001.pdf

Overview

Group-2 Consortium region of interest

- Objectives
- Who are we?
- Reference events
- Validation tests
- Conclusions

Objectives

- Improve locations based on the sparse IMS network, reduce location bias and uncertainties in North Africa, Europe, Middle East and Northwest Asia
- Calculate regional travel time corrections (SSSCs) relative to IASPEI91 for Pn, Sn, Pg, Lg for selected stations in the region by ray-tracing through 3D models
- Develop 3D models (global/regional body/surface wave tomography, regionalized models)
- Collect reference events located with 5 km accuracy or better
- Validate and document reference events
- Validate models and corrections using reference events (demonstrate that locations improve)

Group-2 Consortium

SAIC - Coordination, regionalization, reference event collection, software integration, testing, validation

University of Colorado, Boulder - Regional body/surface-wave tomography, 3D ray-tracing, reference event collection and validation

Harvard University - Global/regional body/surface-wave tomography, reference event collection

University of California San Diego - Model validation, regionalization

Multimax - Reference event collection and analysis

**Geophysical Institute of Israel –** Reference event collection and analysis

Consortium: 2-phase, 3-year project

- Project started in April, 2000
- Task: deliver correction surfaces for IMS stations in the region
- First delivery, June 2001:
  - models based on existing data and models, preliminary correction surfaces for surface sources, reference event list
- Final delivery, January 2003:
  - Final models, refined, depth-dependent correction surfaces, reference event list
- Web site: http://g2calibration.cmr.gov

Reference Events
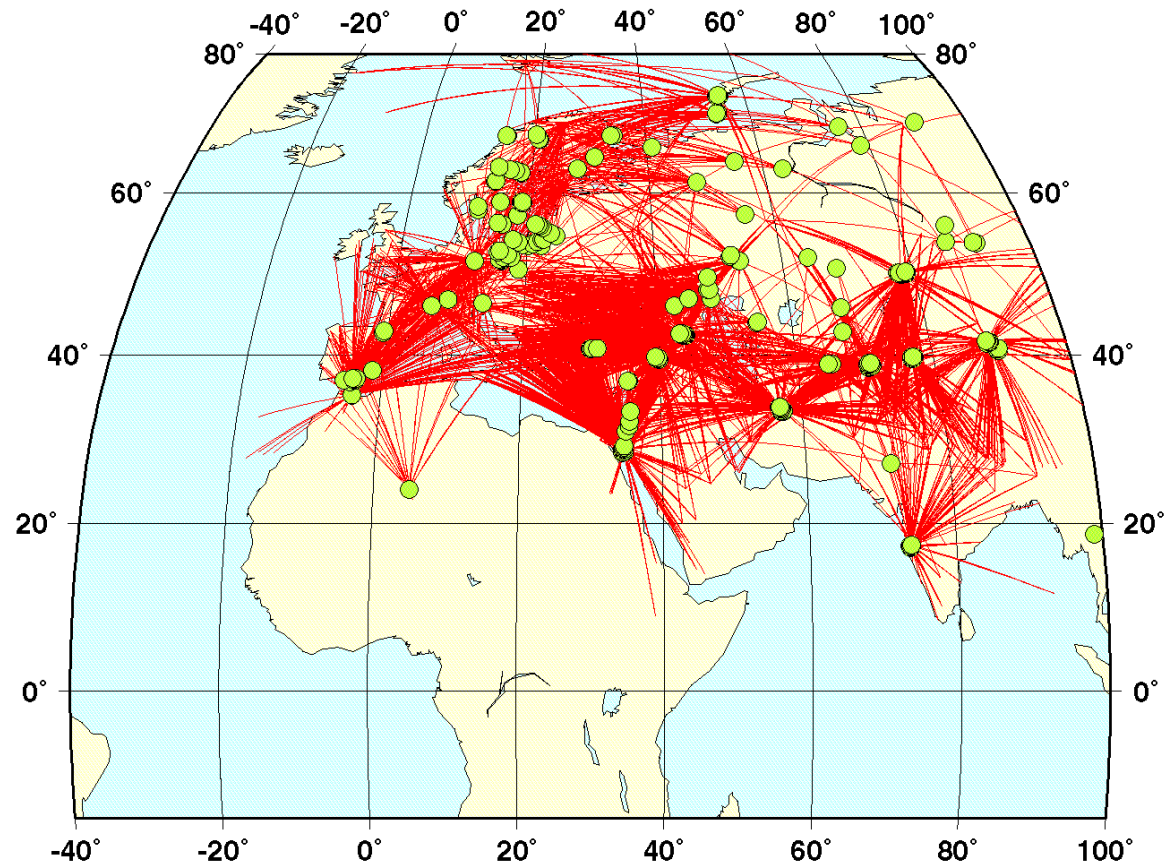
- What is a reference event?
  - GT0: known (published) location of explosions
  - GT2: event tied to a mine with a size ~2 km
  - GT5: local seismic network location
    - 10 or more stations within 250 km with maximum azimuthal gap <= 120 degrees;
    - closest station <= 30 km;
    - P/Pn recorded beyond 250 km;
    - event located using a local velocity model
    - Origin time might still be biased!
- Reference events are validated by cluster analysis (JHD or HDC)
- Cluster analysis can generate further reference events

Reference Events, April 5, 2001
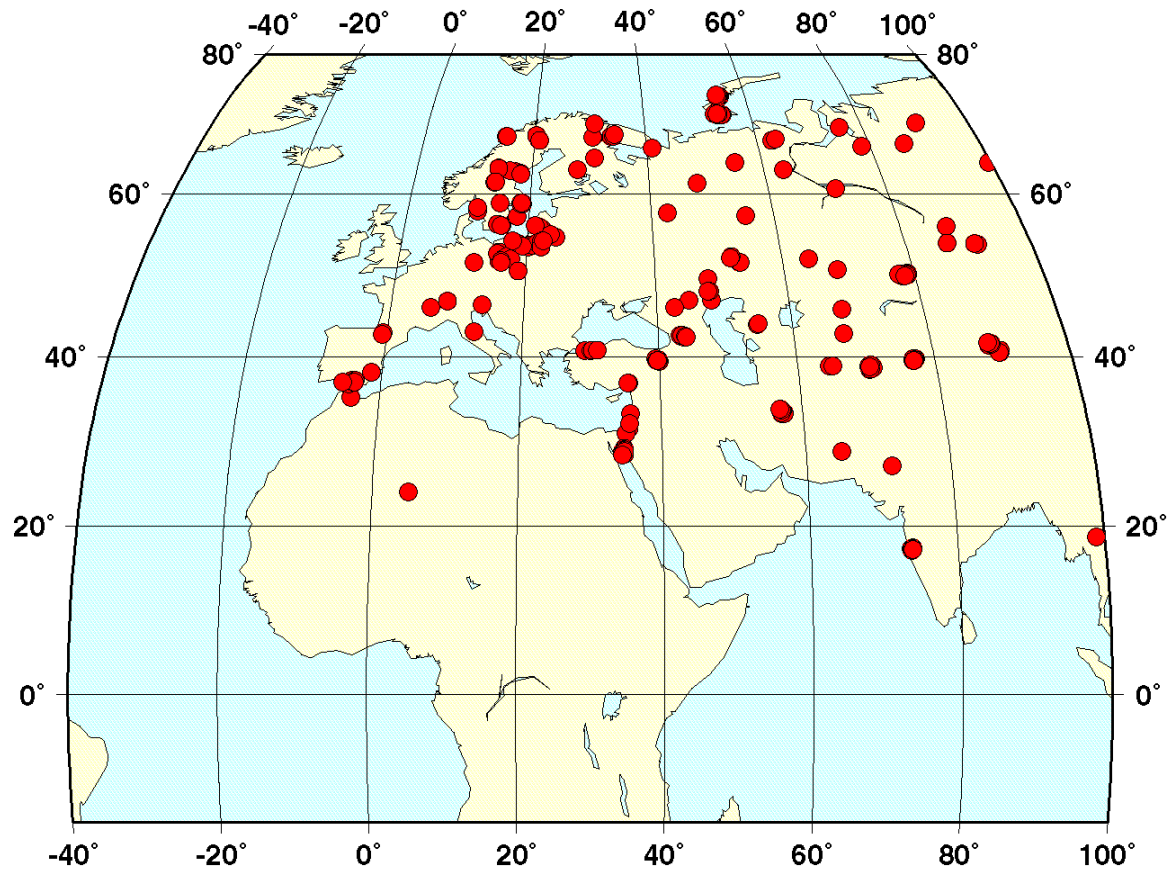
837 GT0-5 events. Download: http://g2calibration.cmr.gov

Regional ray coverage, April 5, 2001

13,012 regional phases, 126,242 arrivals in total from 3,258 stations.
Poor coverage in Africa and in the Middle East.

Validation tests

Objectives:

- Validate models by relocating reference events using any stations in the region
- Validate SSSCs for IMS stations by relocating reference events using only IMS or IMS surrogate stations
- Measure improvements by a suite of metrics
- Integration tests: assess impact of SSSCs on automated and interactive processing

Evaluation metrics

Metrics follow the 1999 Oslo recommendations

When SSSCs are applied:

- Improvements in location of GT0-5 events are statistically significant
- Area of error ellipses is significantly reduced (20% or more for the majority of events)
- Actual coverage approaches 90%
- Variance reduction is achieved

Metrics can be also calculated as a function of ndef, nsta and gap

Additional metrics are being developed

Relocation tests

- Relocate reference events using:
  - Calibrated regional phases only
  - Calibrated and uncalibrated regional phases
  - Calibrated regional and uncalibrated teleseismic phases
  - Calibrated regional and uncalibrated regional and teleseismic phases
- Assess effects of mixing calibrated and uncalibrated travel times
- Improvements should be demonstrated
- Do no harm!

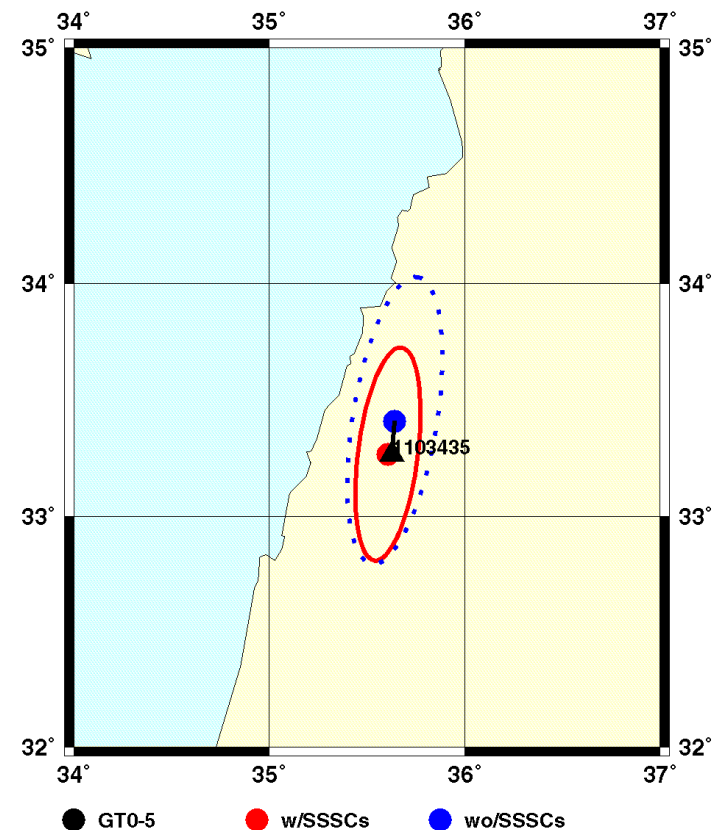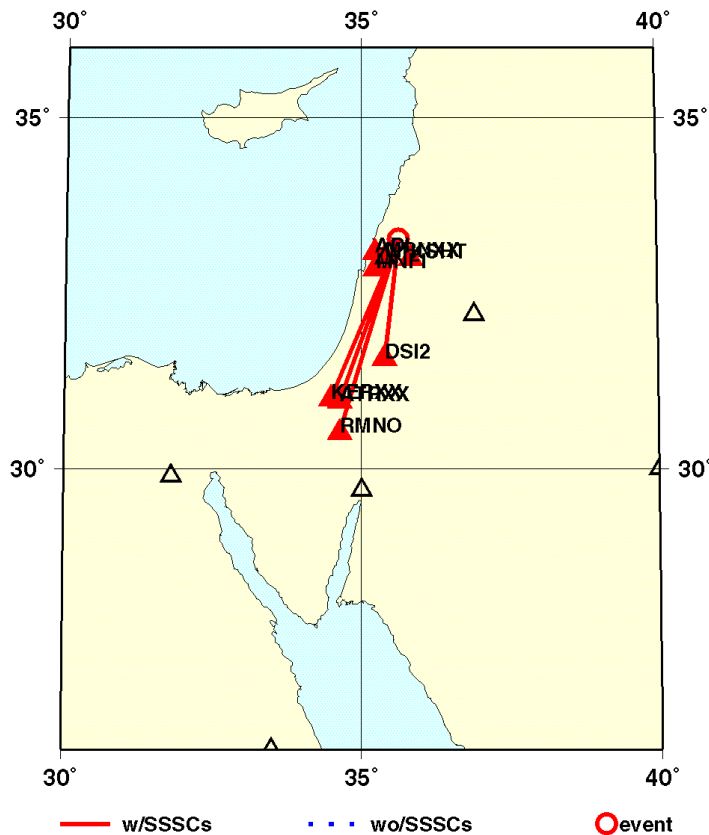# Example: Racha, GT5

SSSCs for all 8 paths

- Mislocation: 1.7 km
- Location improvement: 16 km
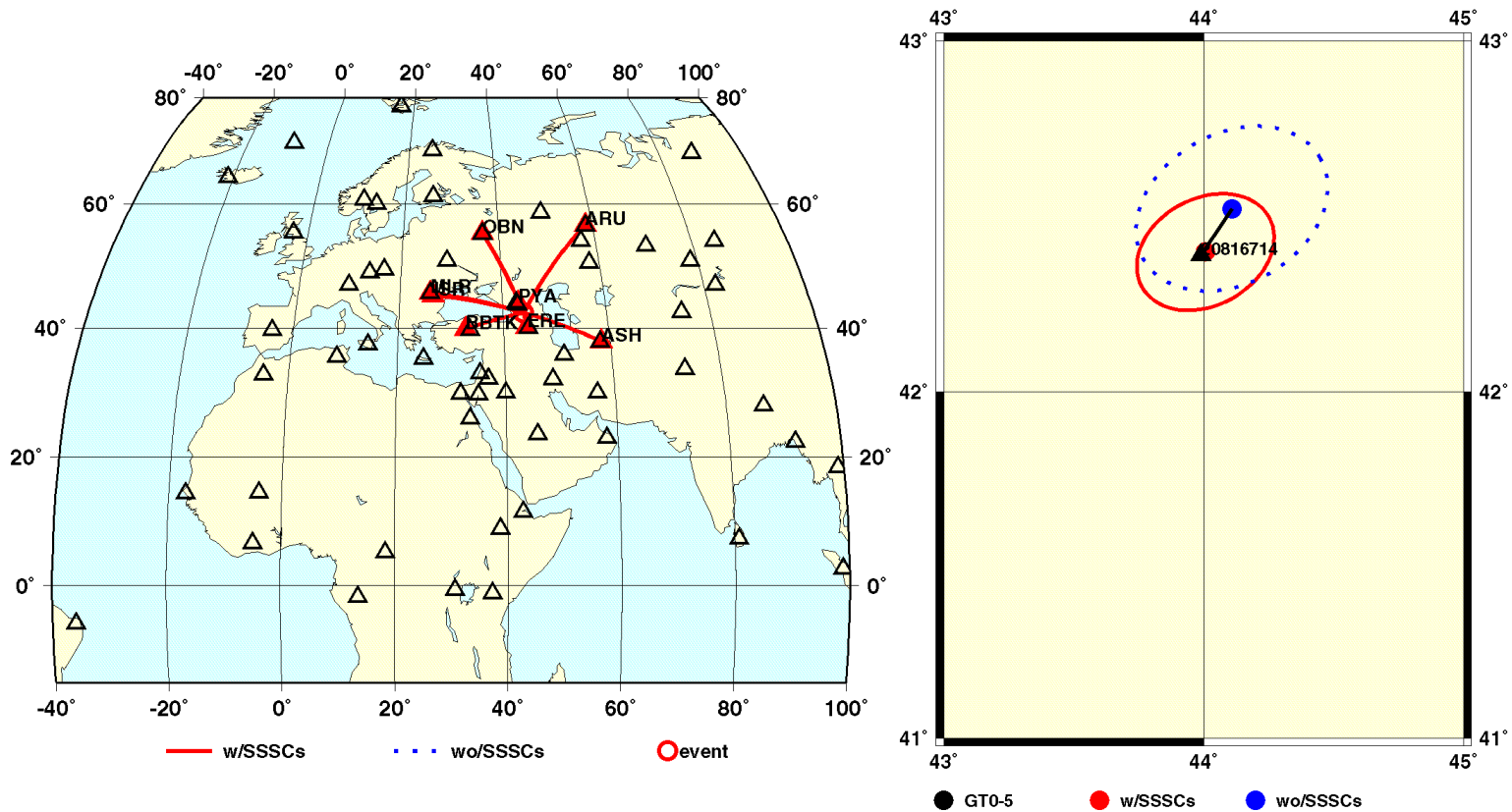
Example: Dead Sea region, GT2

5 paths with, 4 paths without SSSCs

- Mislocation: 1.8 km
- Location improvement: 14 km

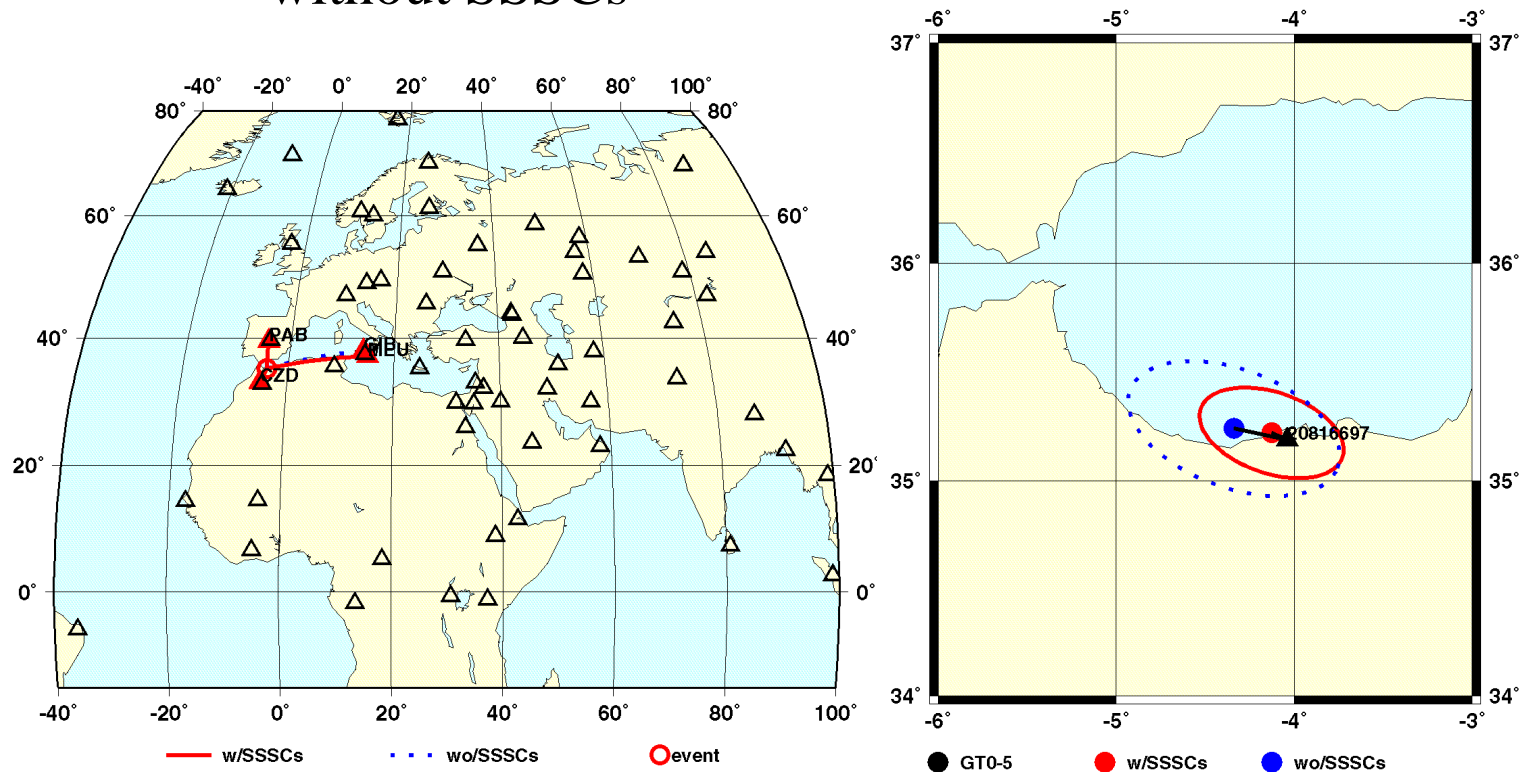# Example: Morocco, GT5

2 paths with, 2 paths
without SSSCs

- Mislocation: 139 km
- Location improvement: 83 km
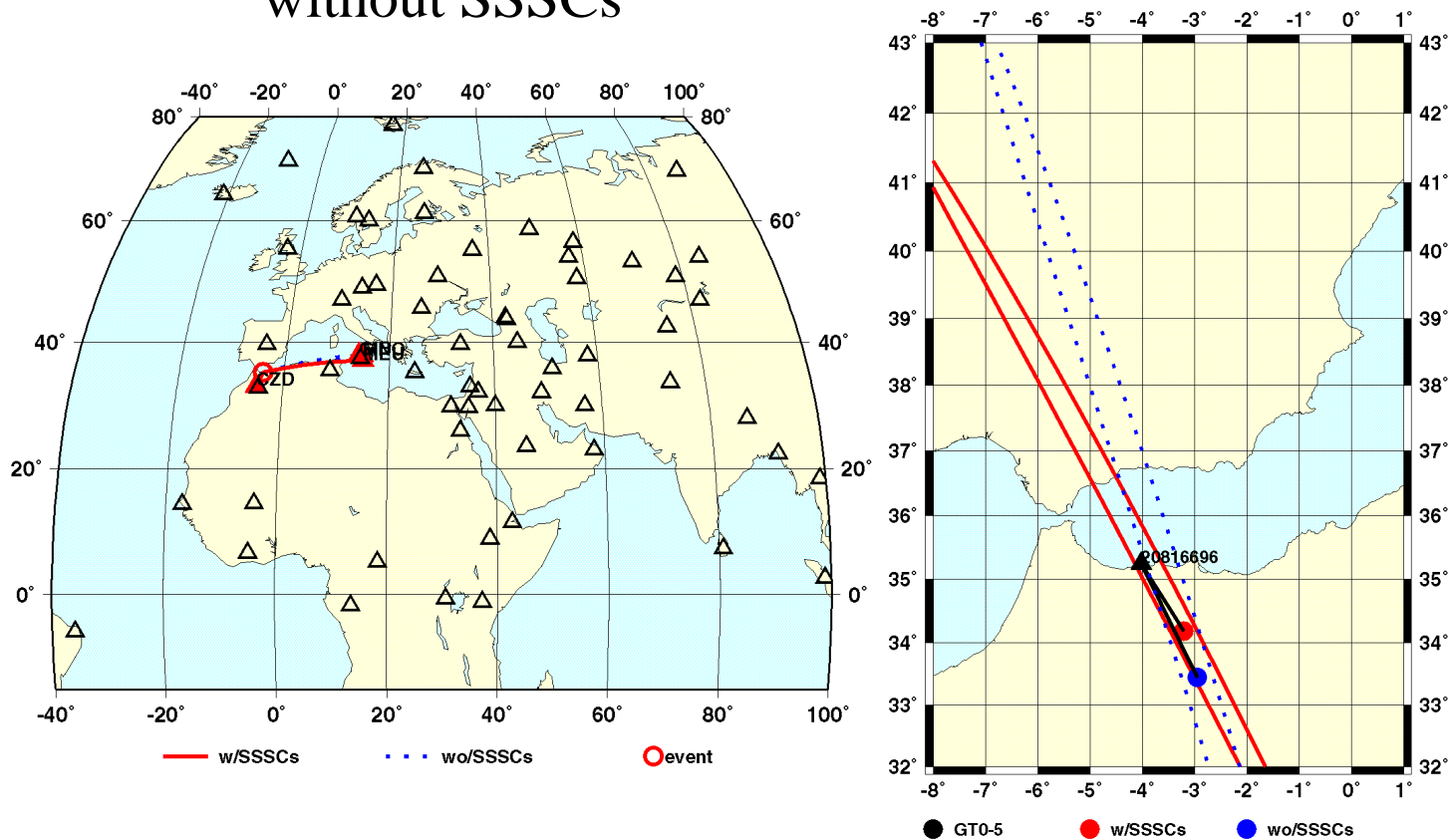
Example: Morocco, GT5

4 paths with, 1 path
without SSSCs
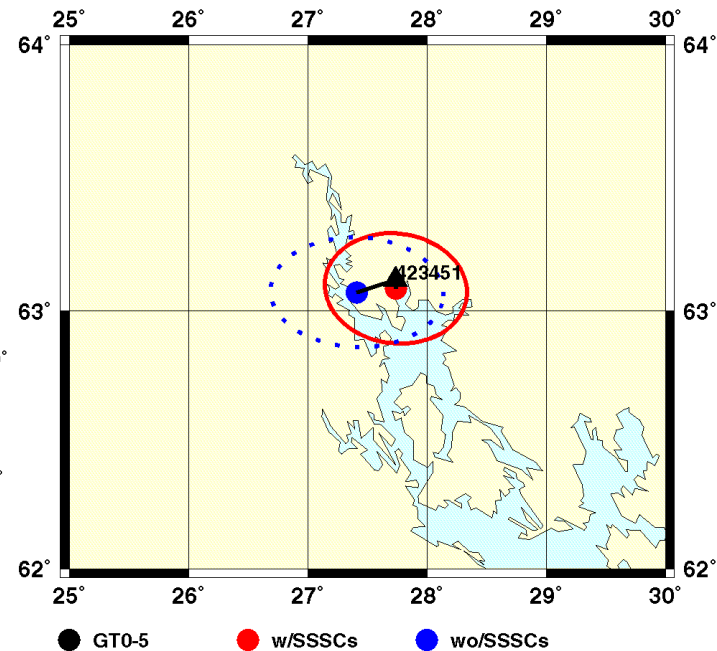
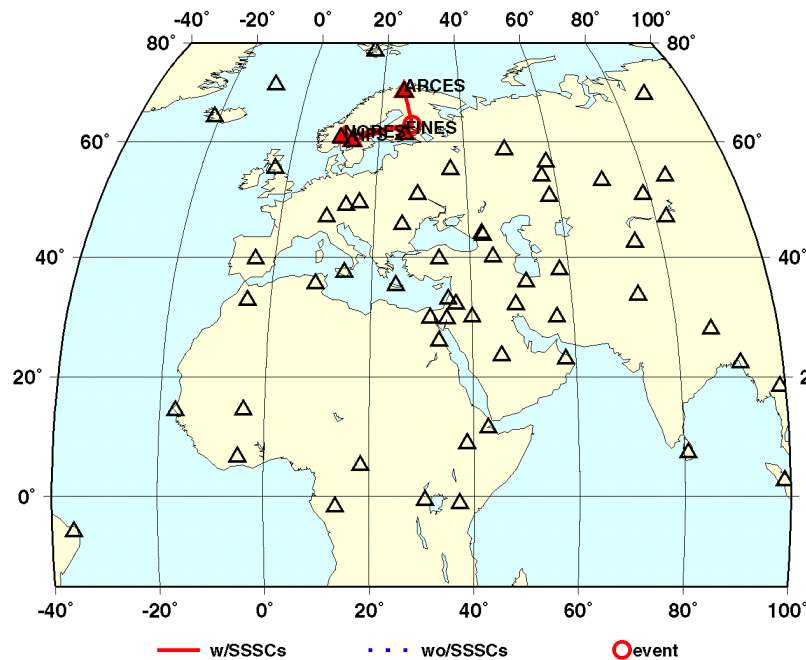- Mislocation: 8.7 km
- Location improvement: 19 km

Example: Finland, GT5

9 paths with SSSCs

- Mislocation: 3.8 km
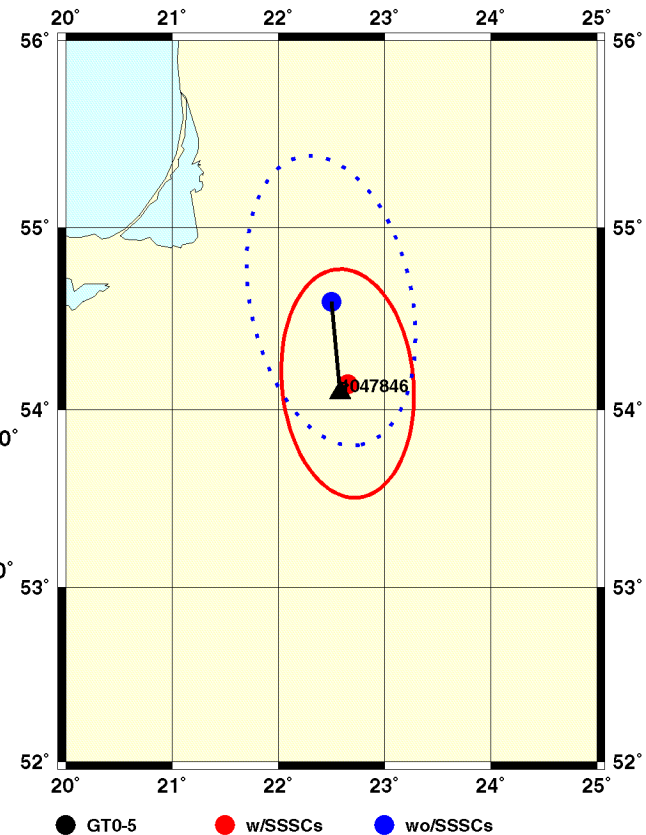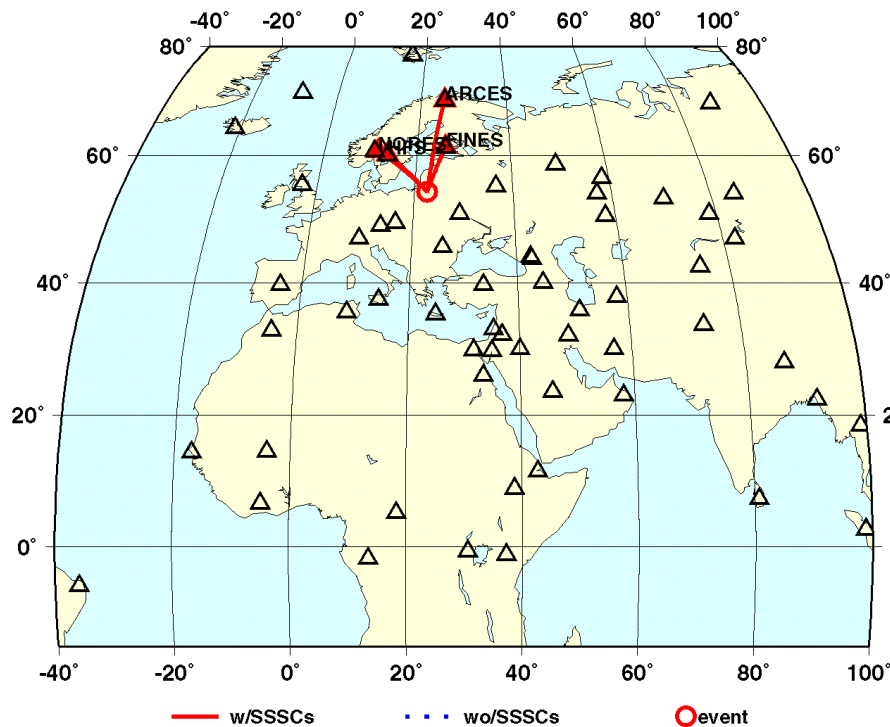- Location improvement: 14 km

Example: Belarus, GT0
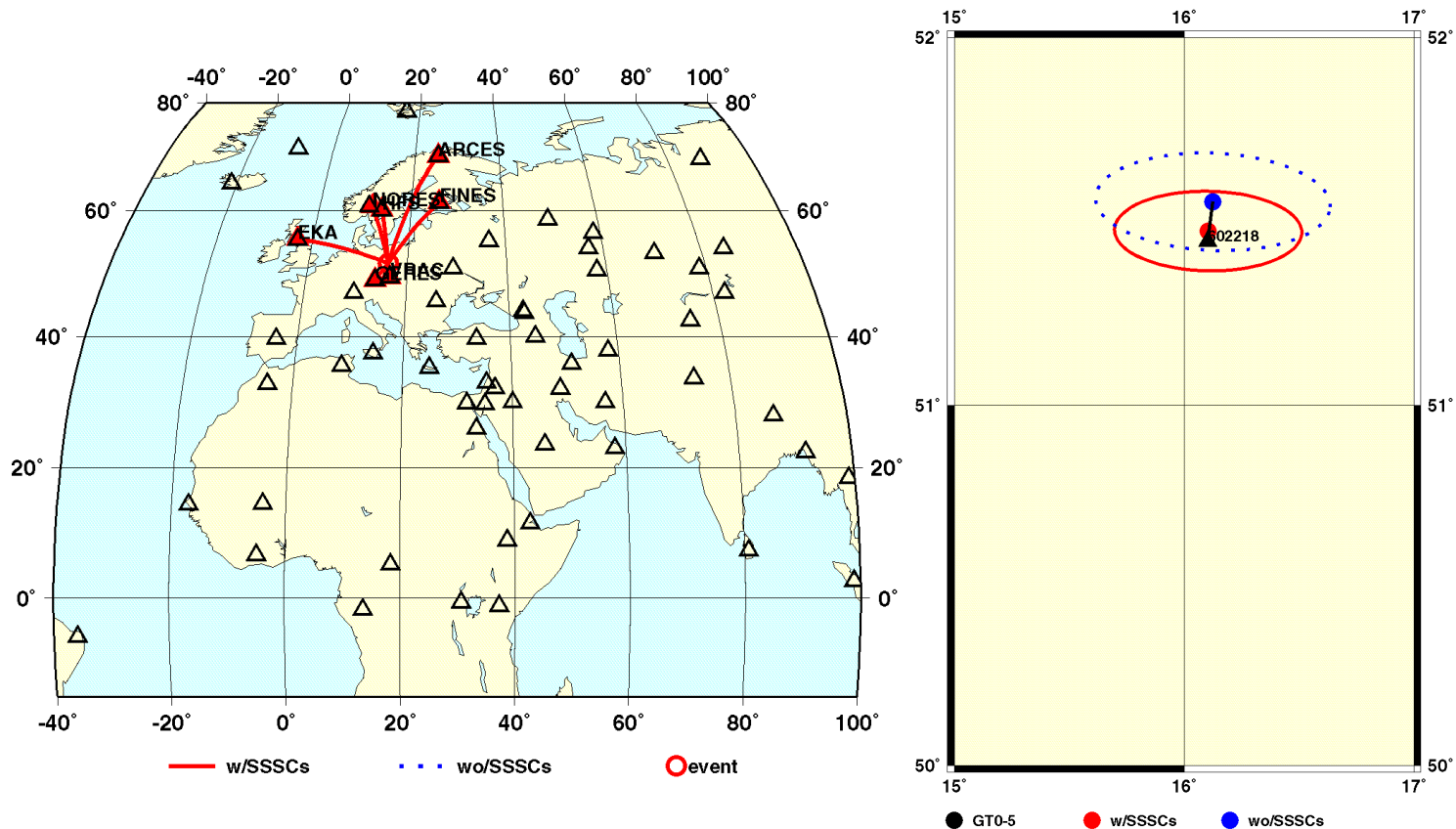
7 paths with SSSCs

- Mislocation: 6.9 km
- Location improvement: 49 km

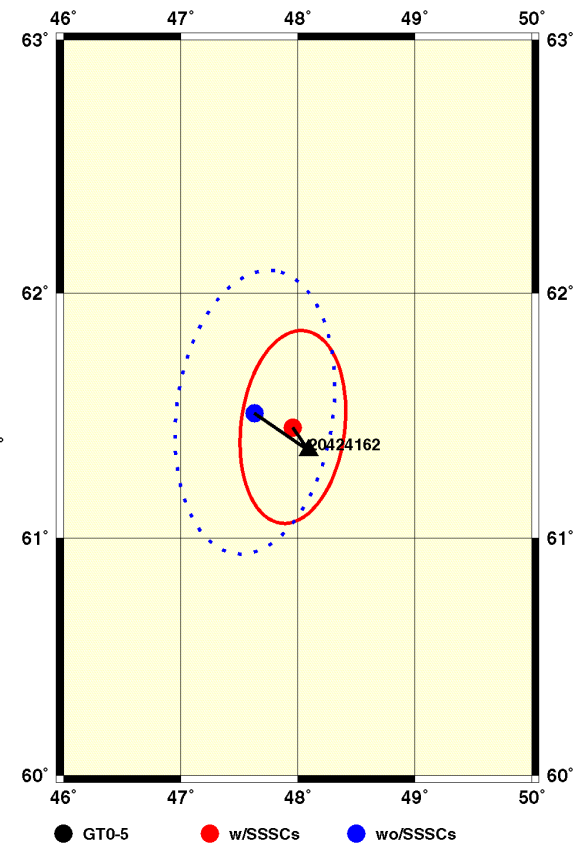# Example: Poland, GT1
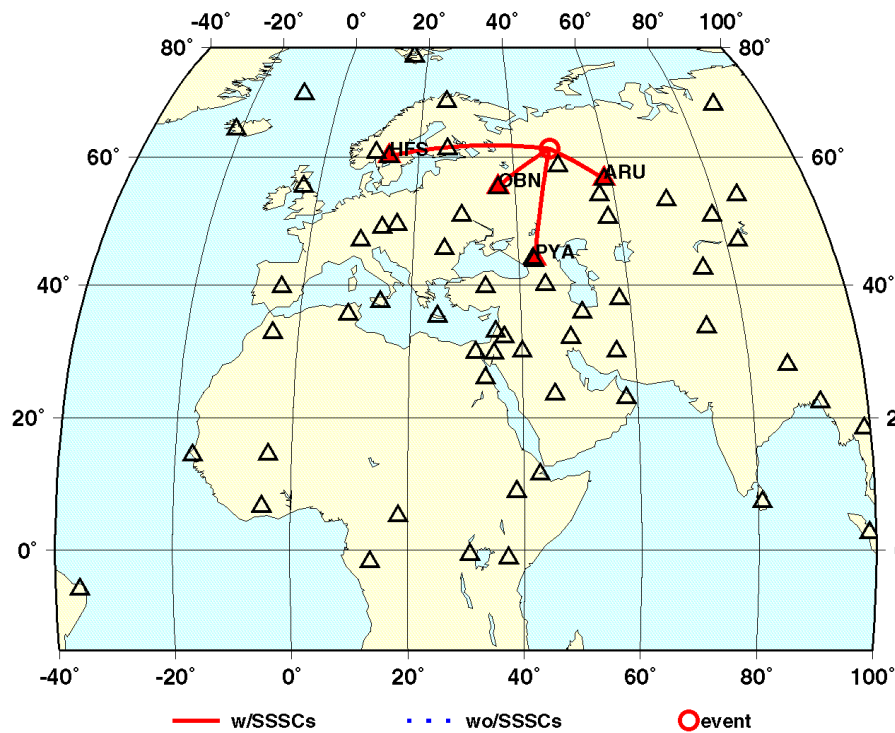
10 paths with, 4 paths without SSSCs

- Mislocation: 3.0 km
- Location improvement: 9 km
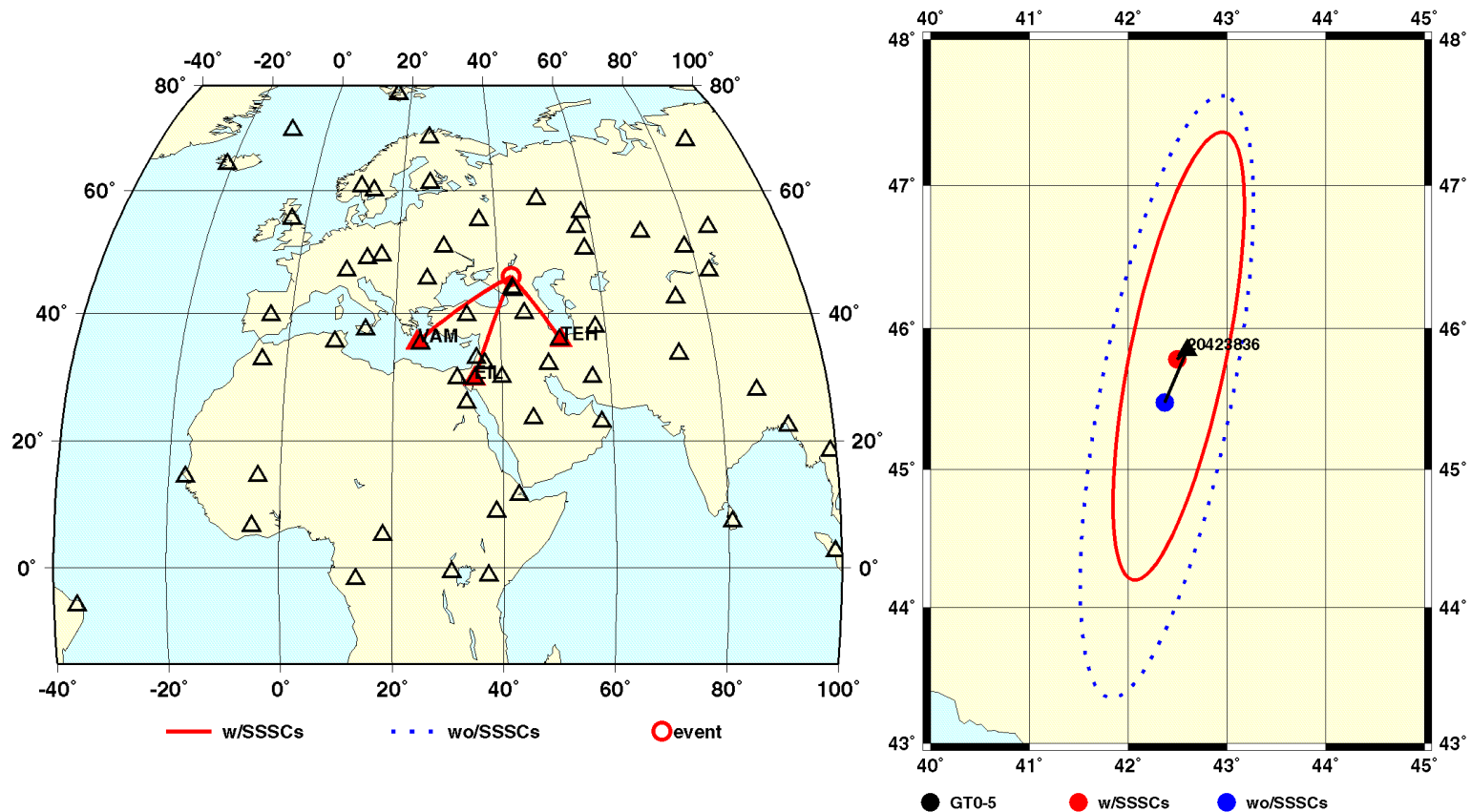
Example: PNE, GT1

5 paths with SSSCs

- Mislocation: 12.7 km
- Location improvement: 17 km

Example: PNE, GT1

3 paths with SSSCs

- Mislocation: 10.4 km
- Location improvement: 34 km

Conclusions and Outlook

- 800+ GT0-5 reference events are collected so far, the number is steadily growing
- Off-line validation tests are being carried out, preliminary results are encouraging
- Phase 1 delivery is due in June
- Final tests will be performed in cooperation with CMR R&D Testbed
- CCB proposal to PIDC expected in Fall 2001
- Phase 2 starts this year
- Quest for reference events is now concentrated on Africa and Middle East
- Validation of GT5 criteria is planned